Precambrian Research 292 (2017) 1–12

Contents lists available at ScienceDirect

Precambrian Research

journal homepage: www.elsevier.com/locate/precamres

Fennoscandia before Nuna/Columbia: Paleomagnetism of 1.98–1.96 Ga mafic rocks of the Karelian craton and paleogeographic implications

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ARTICLE INFO

Article history:
Received 10 September 2016
Revised 9 January 2017
Accepted 18 January 2017
Available online 21 January 2017

Keywords:
Paleoproterozoic mafic dykes and sills
Baltica
Karelia
Paleomagnetism
Key pole
Nuna/Columbia supercontinent

ABSTRACT

Numerous mafic dykes, sills and intrusions with ages between 1985 Ma and 1960 Ma are exposed near the Onega Lake in southern Karelia, Russia. The paleomagnetic analysis of these rocks has revealed a stable remanence with directions belonging to two groups. The directions of the first group characterize ten intrusions including the dated 1970 ± 3 Ma Unoi sill and 1976 ± 9 Ma Suna River Canyon dolerite, the corresponding paleomagnetic pole is 44.4°N, 101.5°E, A_{95} = 6.3°. The second group comprises two intrusions including the 1984 ± 8 Ma Pudozhgora intrusion and Krestoviy Navolok dyke with the corresponding paleopole calculated from 5 site mean poles is 60.9°N, 144.8°E, A_{95} = 6.8°. Both remanence directions are supported by robust baked contact tests. We propose the first group's pole as the key 1975 Ma Fennoscandian pole. The second one is well dated, but based only on two intrusions without proper averaging of the paleosecular variations. We have also carried out a complimentary paleomagnetic study of the previously investigated 2504 Ma Shalskiy gabbronorite dyke. The remanence of this dyke is now supported by the inverse contact test and statistics can be improved. Using our 1975 Ma pole together with coeval poles from Superior, Slave and Amazonia cratons we propose a provisional 1975 Ma paleogeographic reconstruction.

1. Introduction

The 2.0–1.8 Ga time interval in Earth's history is marked by world-spread orogenic events (e.g. Zhao et al., 2009 and references therein). These events initiated assemblies of Laurentia (the cratonic part of North America), Baltica, Siberia, Australia, Kalahari cratons (e.g. Hoffman, 1988; Bogdanova et al., 2008; Rosen et al., 1994; Pisarevsky et al., 2008; Cawood and Korsch, 2008; Hanson et al., 2011) and accretionary growth of others (e.g. Brito Neves, 2011). Most of these and other cratons eventually collided to form the Paleo-Mesoproterozoic supercontinent Nuna (or Columbia) (Rogers and Santosh, 2002; Zhao et al., 2004, 2006; Meert, 2012 and references therein). The time of the final assembly of Nuna/Columbia is debated and estimated between ca. 1800 Ma (Zhang et al., 2012 and references therein) and ca. 1600 Ma (Pisarevsky et al., 2014 and references therein).

Recent studies demonstrate that Baltica (the East European Craton) has not been assembled until ca. 1.8–1.7 Ga (Bogdanova et al., 2008; 2013; Lubnina et al., 2015a). At ca 2.0 Ga, at least three protocratons – Kola, Karelia and Volgo-Sarmatia were separated by oceans (Melezhik and Hanski, 2013; Bogdanova et al., 2008, 2013). The small Kola Ocean between Kola and Karelia was closed at ca. 1.94 Ga (Daly et al., 2006; Melezhik and Hanski, 2013). Starting from ca. 1.90 Ga, the united Kola-Karelia grew in SW- to SSW direction (hereafter – in present day coordinates) by consequent accretion of island arcs and microcontinents to amalgamate Fennoscandia (Bogdanova et al., 2015).

Several early Paleoproterozoic paleogeographic reconstructions around 2.5–2.4 Ga (e.g. Bleeker and Ernst, 2006; Söderlund et al., 2010; Salminen et al., 2014; Pisarevsky et al., 2015) and late Paleoproterozoic, younger than 1.8 Ga (e.g. Pisarevsky and Bylund, 2010; Zhang et al., 2012; Pisarevsky et al., 2014) have been

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http://dx.doi.org/10.1016/j.precamres.2017.01.011
0301-9268/